Helios Mission Support

P. S. Goodwin
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E. S. Burke and G. M. Rockwell
Deep Space Network Operations

This article reports on activities of the Network Operations organization in support of the Helios Project from 15 April through 15 June 1977.

I. Introduction

This article is the sixteenth in a continuing series of reports that discuss Deep Space Network support of Helios Mission Operations. Included in this article is information concerning Helios-2's superior conjunction period, Faraday rotation experimentation during solar conjunction, updated Mark III data system status, and other Mission-oriented activities.

II. Mission Operations and Status

The Helios-1 spacecraft has continued in a normal manner during this period with no significant events occurring. Because of the distance and position of Helios-1 at this time, STDN cross-support at Goldstone has been discontinued. The last STDN pass of this series was conducted on 10 May 1977, and no further coverage of this type will be attempted until October 1977, when conditions will again be favorable.

On 10 May 1977 the Helios-2 spacecraft entered the longest superior conjunction period of its entire Helios Mission. This period will last until 18 October 1977. Helios-2 passed inside the 3-degree Sun-Earth-probe (SEP) angle zone on 20 May 1977 and entered a blackout period on 2 June 1977. This blackout will last until 26 June 1977, when tracking coverage will resume. Because of the length of this solar conjunction period, considerable scientific interest has arisen for DSN tracking coverage during this time. More detail on the specific experiments being conducted while Helios-2 is in this phase of its mission will be discussed later in this article.

Prior to entering superior conjunction, Helios-2 passed through its third perihelion on 23 April 1977 (Ref. 1). The specific detail of this perihelion was that the spacecraft was 149.93 km from Earth, 43.48 km from the Sun, was traveling at a velocity of 68.6368 km/s, and had a communications round-trip-light-time (RTLT) of 16 minutes 40.36 seconds. This perihelion period was supported by DSS 63 in Spain with a bit rate of 2048 bits per second (bps) in Format 1, and data mode 0. In general, all subsystems and experiments functioned properly.

One anomaly occurred during this period, which affected Experiments 1, 2, 3, and 10 on board the Helios-2 spacecraft on 17 May 1977 over DSS 63. The regulator output voltage dropped from 28 volts to 24 volts, Experiment 10 sensor "A" current increased from 105.6 to 170 mA, and Experiment 1 sensor "A" current rose from 1.34 to 2.2 mA (soft limit) and

4.3 mA (hard limit). Subsequent data showed further breakdown of regulator output voltage. It has not been determined what happened, because data received during this time were extremely noisy. It is suspected that a regulator or double regulator switch occurred, which was experienced a few months ago with Helios-1. Over DSS 43 Experiments 1, 2, and 3 were reconfigured with no problems, but Experiment 10 was left off until further troubleshooting could be conducted.

Overall tracking time for both Helios spacecraft is shown in Table 1.

Periods of high scientific interest for Helios-1 and -2 are listed below:

(1) 20 May – 5 June: Helios-2 to be inside the 3-degree zone of superior conjunction. Facilities to measure the Faraday rotation and the signal bandwidth are requested as frequently as possible. Normal coverage requested for Helios-1.

(2) 6 June – 21 June: Helios-2 to be in solar occultation. No coverage for Helios-2 requested. Normal coverage requested for Helios-1.

(3) 22 June – 18 July: Helios-2 to be inside the 3-degree zone of superior conjunction. Facilities to measure the Faraday rotation and the signal bandwidth are requested as frequently as possible. Normal coverage requested for Helios-1.

(4) 18 July: Aphelion of Helios-1.

(5) 25 July: Aphelion of Helios-2.

(6) 30 September – 11 October: Helios-2 to be inside the 3-degree zone of superior conjunction. For requirements, see (1), above.

(7) 8 October – 15 October: Helios-1 to be inside the 3-degree zone of superior conjunction. Facilities to measure the Faraday rotation and the signal bandwidth are requested as frequently as possible. Normal coverage requested for Helios-2.

(8) 9 October – 2 November: Helios-1 to be in its perihelion phase (R 0.4 AU solar distance). This will be the most scientifically interesting of the current orbit phases of Helios-1. Adequate coverage is requested.

(9) 14 October – 7 November: Helios-2 to be in its perihelion phase (R 0.4 AU). Maximum scientific-interest orbit phase for Helios-2. Adequate coverage is requested, especially during that period when both spacecraft will be within 0.4 AU, i.e., from 14 October through 2 November.

(10) 8 – 11 October: Sun-radial lineup of Helios-1 and Helios-2. This lineup will have a high scientific value because it will happen in or close to the perihelion phase when the distance between the two spacecraft is less than 0.1 AU.

(11) 18 – 29 October: Long period of solar spiral lineup Helios-1 and Helios-2. Scientifically it is a very interesting period. As much coverage as possible for both spacecraft requested.

III. Special Activities

A. Mark III Data System (MDS) Support of Helios

The 26-meter subnetwork, made up of stations 12 at Goldstone, California, 44 in Australia, and 62 in Spain, continues to function in a nominal manner using the MDS in support of Helios. The MDS's performance has improved with the updating of its software, which has made the system much more reliable and more efficient. The latest updated software packages were for the Metric Data Assembly (MDA), the Command Processor Assembly (CPA), and the Monitor and Control Subsystem.

At this writing the MDS implementation at DSS 14 (Goldstone) is continuing. Test and training will begin at DSS 14 during June. Helios will be involved in a combined projects data flow test, to check out representative data rates and data types from all projects. Following this test, Helios will conduct demonstration tracks in the same manner that was used for the 26-meter MDS stations. A report on these test and training activities will be presented in the next article of this series.

B. Radio Science Activity

Scientific interest in the Helios-2 mission is very high at this time due to the current superior conjunction phase. One of the major experiments being conducted is the Faraday Rotation Experiment (Experiment 12). The experiment involves the 64-meter subnetwork and utilization of each station's automatic polarizer and Meteorological Monitor Assembly (MMA). At present only DSSs 43 (Australia) and 63 (Spain) are involved. Station 14 (Goldstone) will become involved after it is once again operational following MDS modification.

Significant rotation of the plane of polarization of the received signal is observed to occur whenever the Helios-to-Earth radio signal passes through the solar corona near superior conjunction. The large-scale variations in the polarization data arise most probably from the changing orientation of the solar corona as it rotates through the signal path. If the polarities of the large-scale interplanetary magnetic field sector structure can be mapped into the solar corona (thus fixing the sign of the coronal magnetic field), the most probable distribution of the product $N \cdot B$ (electron density × magnetic field) as a function of heliographic longitude may be determined. This effort is a continuation of the original Helios Experiment 12. The 1977 superior conjunction will probably be the last opportunity to observe this phenomenon with the spacecraft line-of-sight relatively motionless for an extended period of time.

The data types desired by the experimenters are signal polarization angle data, ellipticity data, and Faraday rotation data. These data are sampled by the MMA and recorded on digital tape (refer to Fig. 1). This tape is first played back to JPL in near-real-time, and then is shipped, along with polarimetry chart recordings, to the experimenter at JPL for analysis. At this writing, the first data packages have just arrived at JPL and no results are yet available. A future article in this series will report the results of this experiment.

Radio Science Experimenters are also conducting Solar Wind Experiments (SWE) during this superior conjunction period. These experiments involve remote sensing of the solar wind velocity near the Sun. Data are gathered by simultaneously tracking a Helios spacecraft at two widely separated DSN stations and recording doppler counts and (real-time-generated) pseudoresiduals, from which the solar wind velocity will be estimated. These measurements are scientifically important because they will allow extensive velocity measurements throughout the solar wind acceleration region and will be the first direct measurement of solar wind velocity very close to the Sun. Because of Helios-2's long solar occultation, observations in 1977 are unique and offer an important opportunity to thoroughly study this region of the solar atmosphere. The desired coverage of the experimenters is listed in Table 2. Results of this experiment will be reported in a future article in this series.

Reference

1. Goodwin, P. S., Burke, E. S., and Rockwell, G. M., "Helios Mission Support," in *The Deep Space Network Progress Report 42-39,* pp. 17-22, Jet Propulsion Laboratory, Pasadena, Calif., June 15, 1977.

Table 1. Helios tracking coverage

Month	Spacecraft	Station type	Number of tracks	Tracking time, h:min
April	Helios 1	26 Meter	51	313:26
		64 Meter	9	62:03
	Helios 2	26 Meter	50	377:39
		64 Meter	23	162:11
May	Helios 1	26 Meter	44	340:59
		64 Meter	0	0
	Helios 2	26 Meter	36	143:22
		64 Meter	37	215:47

Table 2. Requested coverage for solar wind experiment

Spacecraft	Period (1977)	Coverage[a]
Helios 2	April 23 - November 1	At least 3 passes per week. Passes not required when Helios is too close to the sun for tracking (approx. June 19 ± 10 days). Within 1° of sun 64-m antennas (43/63) are requested.
Helios 1	April 23 - September 1	At least 1 pass per week.
Helios 1	September 2 - November 1	At least 2 passes per week.

[a]Minimum of one hour of simultaneous coverage is desired for each pass.

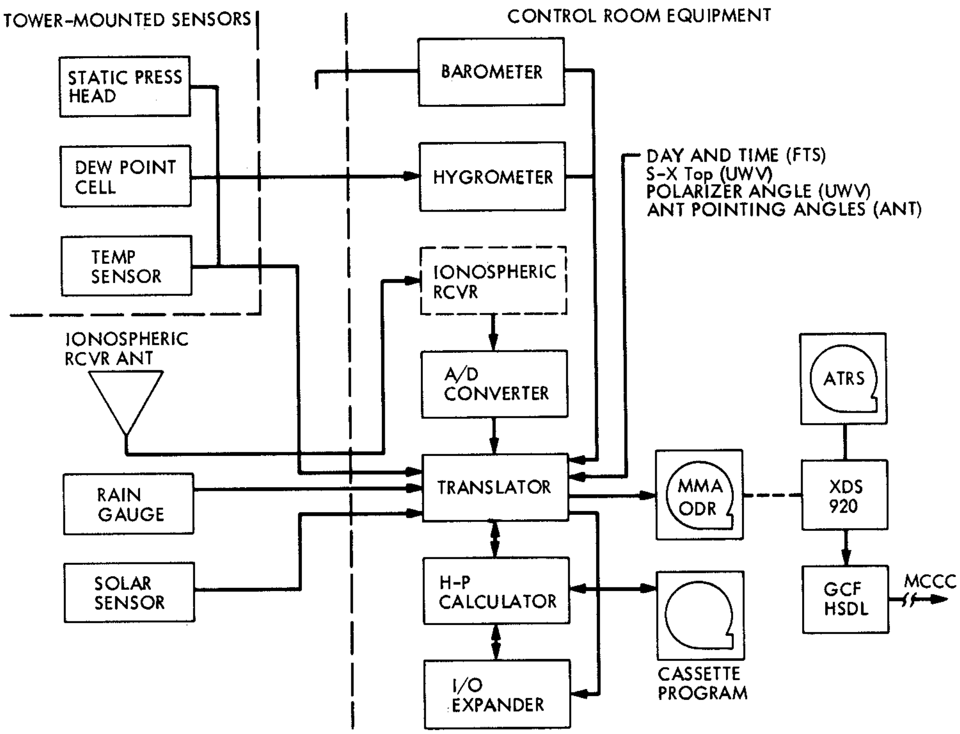

Fig. 1. Simplified MMA system block diagram